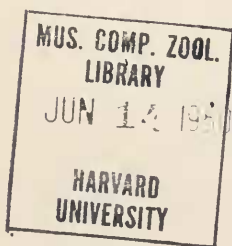


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DISTRIBUTION AND ORIGIN OF
THE BIRDS OF MEXICO

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No. 6. — *Distribution and Origin of the Birds of Mexico*¹

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PREFACE

The author's interest in the birds of Mexico and Central America has extended for a period of over thirty years. The present paper was a logical outcome of study in recent years, during which he has had the privilege of being associated with R. T. Moore and Dr. Herbert Friedmann in the preparation of a distributional check list of the birds of Mexico (cf. announcement, *Auk*, 1944, p. 173). He has examined specimens of every species of Mexican and Central American birds, nearly every genus and species of South American birds, and has had field experience in life with over two-thirds of the species analyzed beyond.

Every effort has been made to present the subject in a manner so as to make it as interesting as possible for naturalists in general, and to reduce to a minimum the necessity for expert systematic knowledge of tropical American birds to get the point of the argument. For this reason English names have been freely used for family, genus, and species, whenever familiar and available, but none have been invented. With the several long lists of migrants and visitants, all come from the

¹Abstract presented to the Ecological Society of America, Chicago meeting, December, 1947, at a symposium on Mexico, and published with the aid of a special gift from Mr. George R. Agassiz.

United States, and all are such familiar and well known birds that space has been saved by not itemizing every species, with its technical and common name. Anyone interested can find this out for himself by consulting any standard bird guide or text-book. Similarly the long list of some 255 Sonoran endemics is not carried beyond a summary of each genus; the great majority of these species are known only to technical experts and possess no English names.

The division of Mexico into faunal areas or biotic provinces is outside the province of this paper, and is a study on which improvements will be made for another half century at least. Readers should recall that our knowledge of Mexican birds today is approximately equal to what ornithologists knew about the birds of the United States in 1875. For this reason there is no detailed description of the topography, climates and vegetative areas of the Republic, because these details are required chiefly to explain the distribution of local species within Mexico and innumerable subspecies. The best summary ever written of this subject (Nelson & Goldman, 1926) was prepared under the auspices of the Ecological Society of America, and there is no point in recapitulating it here.

INTRODUCTION

Modern Mexico, in the political sense, has a relatively enormous avifauna of some 2200 named forms (species and subspecies) of birds, with another 150 in the adjacent republic of Guatemala. One bird in every 17 known on earth consequently occurs in this area. Factors of major importance are its central geographic position, and an exceedingly complex and varied topography, with a great diversity of climates and habitats. High mountain ranges and low valleys succeed each other with bewildering rapidity over the whole of the great tableland. Many widely ranging resident mountain and valley species constitute a series of isolated populations, which have existed in their present ranges sufficiently long to evolve a welter of local endemic subspecies. A steady stream of these are still being described. Some 1000 species are therefore represented by a total of 2350 subspecies. Even so, Mexico has been one of the last areas on earth to produce ornithological discoveries of note, three monotypic genera and several distinct species having been found there in the past twenty years.

Any broader analysis of the families, genera and species of birds of Mexico depends upon the approach selected. The first and oldest approach to zoogeography was naturally a purely descriptive or geographic one. The zoogeographical Regions of Wallace and Sclater, into which the world was divided, accepted the conditions of the

present. Regions were characterized by possessing a striking number of peculiar families, subregions and faunas by peculiar genera and species, the many wide ranging ones dismissed as of no significance. The concept of these regions was based almost entirely upon the relatively well known mammals and birds. On this approach North America and most of Mexico was in the Nearctic Region, everything else was the Neotropical Region (including all high mountains and temperate South America!) and there was debate as to the existence of a Central American Subregion and just where the northern limits of the Neotropical Region were. I attempted to show that there was no such thing as a Central American Subregion and that the northern limits of the Neotropical Region were the narrow tropical lowlands of northern Central America and southern Mexico. (Griscom, 1932, 1940, 1945)

Criticism of this approach has been steadily accumulating for some decades. As the distribution of other animal groups, older in the historical or evolutionary sense, became better known it turned out not to fit at all or poorly, the degree of the misfit more or less in proportion to the greater antiquity of the group. The botanists proceeded to divide the world into phytogeographic areas, which presented a picture so hopelessly at variance with the zoological Regions, that no specialist in either field has dared to offer an attempted reconciliation for two generations.

In the meantime the fossil record of mammals, reptiles and a few other groups improved by leaps and bounds, and the picture of the proved or probable place of origin of many animals became clearer. There ceased to be much point in thinking of the so-called "characteristic" families of Neotropical mammals, for instance, as most of them proved to originate somewhere in the Northern hemisphere, and many of them were known to be recent immigrants to South America. (Matthew, 1915). This thesis was greatly extended by Simpson (1940). Dunn (1931) made a brilliant survey of the New World herpetological faunas, and received corroboration from Simpson (1943). This second method of approach may well be called the historical.

Chapman (1917, 1926) was actually the first ornithologist to attempt by analytical methods to deduce the probable or possible origin of tropical American bird life (the Andes of Colombia and Ecuador). He considered species and subspecies primarily and a percentage of the genera only, but left families severely alone. His methods were adopted by me in a study of the birds of Guatemala (1932), but a partial historical approach was attempted, and I was able to show (1) an older pre-glacial element, (2) an invasion from the North during glacial time, and (3) a recent invasion from the South with the return

of warmer climates, which has brought many Neotropical birds to their present northern limits with little or no evolutionary change. These conclusions were accepted by Chapman (1940, pp. 413-418), who had already indicated the "northern" origin of the so-called "Neotropical" family of motmots (1923), the "Neotropical" species, *Parula pitiayumi* (1925), and certain elements in the upper zonal bird life of Mt. Roraima and Mt. Duida (1931, p. 51). I adopted a primarily historical approach to a popular discussion of North American birds in *Modern Bird Study* (1945, chapt. IX, pp. 146-153), showing that (1) certain families were recent arrivals from the Old World; (2) others had invaded the New World at least twice, and that North America had been an important secondary center of evolution for the older element; (3) a group of families have been in the New World for so long a time, and they have undergone so much differentiation from their Old World relations, that it is impracticable to guess or infer just where they originated. Mayr (1946) made a thorough study of New World families along similar lines, but carried his speculations with certain families a little further than I care to go. Even so, about one third of the families remain unanalyzed (through no fault of his). His paper is chiefly remarkable for omitting all reference to most of the recent ornithological literature on the distribution and relationships of American birds. It has been criticized for suggesting sweeping systematic changes to suit his preconceived ideas, in my opinion unfairly, as none were original with him in this particular paper.

Simpson (1943, p. 414-415) has a sympathetic word to say about the difficulties of the ornithologist. Historical studies that are really conclusive are based on an adequate to excellent fossil record; they are particularly difficult, speculative and inconclusive, where the fossil evidence is hopelessly meager, as in birds. Again the Class Aves is the most homogeneous group of vertebrates. As Elliot Coues brilliantly said many decades ago, the differences between any two orders of birds approximate those between two families of reptiles. One result is that about half the birds on earth belong in one order, divided into innumerable "families of convenience" based on trivial and inconstant superficial characters. For every artificial family there is a peculiar genus of birds which will not fit into any! In several very large tropical American families based on internal characters (not determinable in the museum skin), hundreds of species are currently assigned to these families without a shred of evidence that they possess the necessary internal characters! Some day a radical rearrangement of all these families will become possible.

In the meantime there is far too much flogging of a horse already dead. Dr. Mayr is criticized, for instance, for transferring the peculiar

little gnatcatchers (*Polioptila*) from the Old World warblers, "Sylviidae", to the Old World flycatchers, "Muscicapidae," without giving any adequate reasons, and generations of Americans have been brought up to believe that the Muscicapidae did not occur in the New World. But actually these two "families" are mere sections of one family of Old World "insect-eaters". A minor point of routine taxonomy does not impair Dr. Mayr's main thesis that *Polioptila* is a highly modified little bird of undoubted Old World origin. Similarly it makes no difference whether the vireos are treated taxonomically as a family or a subfamily. Either way they are a readily recognizable little group of New World birds which developed in Middle America. Finally those naturalists interested in the historical approach rather than the geographic or descriptive approach would do well to recall that their studies could not have begun, until the geographical distribution of living orders, families and genera had become known with reasonable completeness. The facts of tertiary palaeontology would lack much of the interest they possess today, if we still had to start looking for the living descendants of these animals.

One natural result, however, is confusion in the use of certain terms, as they mean different things in these two methods of approach, and neither may be the routine popular usage. Thus, any traveller crossing the Tropic of Cancer has reached the tropics in a latitudinal sense. The avian geographer talking of the tropical zone birds of Mexico is thinking in terms of climate. The historical zoologist in talking of a tropical group of birds means that it evolved in a tropical climate, or now survives only in such a climate. In Temperate Chile is found a little woodpecker, *Dendrocopos lignarius*. The genus is widely distributed throughout the Northern hemisphere, few species occur in tropical climates, and in the New World the group is lacking between the mountains of Central America and temperate South America. The word fauna is therefore used in two radically different senses.

a. *Dendrocopos lignarius* is a member of the bird fauna of Chile, and actually is one of many striking genera and species endemic there, which collectively characterize and serve to define the well known Chilean South Temperate Faunal Area. Any competently observant naturalist visiting this fauna or faunal area for the first time could tell his first day afield that he had entered a new and different world. The fact that the ancestors of these striking birds may have migrated to Chile from very different directions, at different periods of time, and for different reasons, and that some of them may be genuinely autochthonous, does not invalidate this concept, or reduce it to mythology, as Dunn would have us believe.

b. The genus *Dendrocopos* is a member of an Old Northern, possibly

Palaeartic, Fauna which anywhere after late Tertiary time migrated all the way to southern South America, later becoming extinct and leaving one relict survivor behind. One of the elements in the bird life of Chile is, therefore, the Old Northern or Palaeartic Fauna.

Dunn recognized three faunal elements in the New World:

- 1) Holarctic — a modern, circumpolar element.
- 2) Old Northern — a more southern, older element.
- 3) South American — a still older element, developed during the long isolation of this continent in Tertiary time.

As all three elements could be recognized in nearly every part of Central and South America, he saw no point in trying to differentiate a Neotropical Region from a Neartic Region, and his point is well taken.

Simpson suggests five regions or zones, from a "more directly zoogeographic viewpoint":

- 1) Boreal North America — the northern zone (Canadian Zone northward) characterized by Dunn's Holarctic fauna.
- 2) Middle North America — most of the United States.
- 3) Southern North America — chiefly Mexico, and Central America in the mountains.
- 4) Equatorial South America.
- 5) Austral South America — the cooler or temperate part, including the Andes at increasing altitudes northward.

These "regions" are to be thought of in a general way as important primary or secondary centers of evolution. Not only do they contain many peculiar families and endemic genera living today, but in at least three of them the fossil record proves the evolution of a rich and varied fauna in the past, now extinct or driven out by climatic change.

Geologically Mexico is an ancient land, always a southern extension of the continent of North America. A Central American land bridge existed into early Eocene time, but was broken into two or three islands during much of the Tertiary, and this land bridge was not restored until the middle or late Pliocene. A water gap across the isthmus of Tehuantepec existed from at least late Miocene to middle Pliocene time. The highlands of Chiapas, always connected with the Altos of Guatemala, were part of an island separated by the Nicaraguan gap from the mountains of Costa Rica and Western Panama, another island. There was consequently one barrier or another separating North from South America for most of the Tertiary, and the mingling of the mammal faunas ceased except for random vagrancy. This period of isolation is beautifully brought out in the mammals and indicated for some reptiles. Suddenly in late Tertiary time the North American mammals reached South America, but few if any new

families have evolved in the period of time involved. Unfortunately no such clear division can be made in the birds. In the first place too many of the passerine families are trivial, and in the second place, the restless motility of birds and their known powers of flight and dispersal would have greatly reduced the effect of these water gaps. All islands in the world, with adequate vegetation, have a varied land bird fauna, no matter how great the water gap, or how isolated from a continental land mass. Untold multitudes of land birds throughout the world today think nothing of migrating across the sea for much greater distances than were involved by any Middle American water gap, and the assumption that no land birds ever did it in Miocene time has nothing to support it. Considerable mingling of the Old Northern and the Old South American avifaunas in Middle America during the Tertiary can be assumed with confidence.

ANALYSIS OF MEXICAN AVIFAUNA

With these few words of introduction, let us turn to an analysis of the rich bird life of Mexico, and see what can be done in spite of a hopelessly meager fossil record. The avifauna of Mexico can be divided into seven categories¹. The word endemic is used in a faunal, and not a strictly political sense.

I. The more pelagic sea birds.

Three orders of birds have developed many highly pelagic or exclusively marine species. In many cases these birds spend the greater part of the year at sea, resorting chiefly to lonely and remote islands to breed. Mexico is bountifully possessed of such suitable islands off both coasts, and as a result has an exceptionally large list.

a) Breeding.

Shearwaters (<i>Puffinus</i>)	3 species
Petrels	5 "
Tropic-bird (<i>Phaethon</i>)	1 "
Booby (<i>Sula</i>)	4 "
Cormorant (<i>Phalacrocorax</i>)	4 "
Bridled Tern (<i>Sterna anaetheta</i>)	1 "
Sooty Tern (<i>S. fuscata</i>)	
Noddy (<i>Anous stolidus</i>)	1 "
Fairy Tern (<i>Gygis alba</i>)	1 "

¹ Thorough taxonomic revisions along modern lines will reduce the number of genera currently recognized, and some species will also prove to be races of a more inclusive species.

Of these one genus (marked with an asterisk) and six species are endemic in the general area, as follows:

- Puffinus opisthomelas* (Black-vented Shearwater)
 " *auricularis* (Townsend's Shearwater)
Oceanodroma macrodactyla (Guadalupe Petrel)
 " *melania* (Black Petrel)
 " *homochroa* (Ashy Petrel)
 **Halocyptena microsoma* (Least Petrel)

b) Occurring as visitants off-shore.

Albatross	3 species
Shearwaters	8 "
Petrels	2 "
Tropic-bird	1 "
Gannet (<i>Sula bassana</i>)	1 "
Cormorant	1 "

It can be argued that the Cormorants do not strictly belong here, as not being sufficiently pelagic. They could variously be regarded as Old Northern or Nearctic. In all, only seven families are involved, all old and world-wide types of unknown origin.

II. West Indian Element.

The island of Cozumel (and adjacent islets in part) off the Yucatan Peninsula has long been famous for certain birds of obvious West Indian affinities. A few occur on the adjacent mainland of Yucatan. The flora of Yucatan is known to have a substantial West Indian element. Accidental arrival as a result of the frequent West Indian hurricanes is sufficient to account for both, rather than invoking a former land-bridge, highly speculative and unprovable. (Griscom, 1926b).

- Colymbus dominicus dominicus* — the West Indian subspecies
Phoenicopterus ruber (Flamingo) — also Greater Antilles, north coast of South America, Galapagos
Pandion haliaetus ridgwayi — the West Indian Fish Hawk
Columba leucocephala (White-crowned Pigeon) — typically Greater Antilles
Zenaida aurita yucatanensis — a race of the West Indian Zenaida Dove
Leptotila jamaicensis gaumeri — otherwise peculiar to Jamaica
Crotophaga ani — the West Indian species
Tyrannus dominicensis — the West Indian Gray Kingbird
Elainea chinchorrensis — closely related to the next
 " *martinica remota* — otherwise on the Lesser Antilles

Troglodytes martinica beani — not a race of the continental *T. musculus*, Hellmayr notwithstanding

Vireo magister — a curious species confined to this area and the keys and islands off British Honduras and Honduras. It has Antillean relatives, and may not be specifically distinct.

Coereba bahamensis caboti — very different from the mainland species, *C. mexicana*

Dendroica petechia rufivertex — nearest Lesser Antillean members of the group and distinct from the mainland form

Spindalis zena benedicti — the genus otherwise confined to the Greater Antilles

Tiaris olivacea intermedia — nearer Antillean members of the group, and distinct from the mainland form

These seventeen birds add twelve *species* only to the avifauna of Mexico of which one only might be regarded as endemic.

III. Widely ranging Element.¹

Having already remarked on the powers of flight and the extreme motility of birds, we must now add a characteristic that makes so many of them difficult to analyze, and that is their extreme adaptability. The birds in this group are selected for one main reason only; many range not only throughout the tropics of the New World, but in temperate latitudes also. Moreover they are *resident* in their total ranges, the great extent of which is not due to migration. Chapman dismissed all birds in this category as of no zoogeographic significance. The imagination is staggered to reflect on the number of ecological associations, biotic provinces, and microclimates in which they are at home, which is reflected in considerable subspecific variation. The subject is well worth emphasizing to ecologists, as it explains why birds are about his poorest "indicators". The botanist recognizes a small number of aggressive weeds, but in most continents, the avifauna of any area within it consists of a sizable percentage of such birds. When to these we add the pan-tropical species, another very large list, and the northern species which migrate to far southern latitudes, a substantial percentage of the birds of the whole continent are involved, provided the area selected is *in or near the Northern Hemisphere*. It is not so true of South Africa, Australia and most of South America. This generalization may be taken to suggest the northern origin of most orders and older families of birds, and therefore these wide ranging birds may prove to have some zoogeographic significance after all.

¹The classification and nomenclature adopted follow Peters, Check List of Birds of the World, and Hellmayr's volumes of the Catalogue of Birds of the Americas.

a) Occurring in both temperate and tropical latitudes and climates.

Pelicanidae	Brown Pelican
Anhingidae	Anhinga
Fregatidae	1 species resident plus 1 species visitor
Ardeidae	herons, 10 species
Ciconiidae	Wood Ibis
Threskiornithidae	ibis, 3 species
Anatidae	Cinnamon Teal and Fulvous Tree Duck
Cathartidae	New World vultures, 2 species
Accipitridae	hawks, 16 species
Falconidae	hawks, 11 species
Aramidae	Limpkin
Rallidae	rails, gallinules, 9 species
Jacanídae	Jacana
Haematopodidae	oyster-catcher, 1 species
Charadriidae	plover, 4 species
Himantopus	Black-necked Stilt
Laridae	terns, 6 species
Rynchopidae	Black Skimmer
Columbidae	<i>Columba fasciata</i> , Band-tailed Pigeon <i>Zenaidura macroura</i> , Mourning Dove <i>Zenaida asiatica</i> , White-winged Dove <i>Columbigallina passerina</i> , Ground Dove
Tytonidae	Barn Owl
¹ Strigidae	<i>Bubo virginianus</i> , Horned Owl <i>Speotyto cunicularia</i> , Burrowing Owl
Apodidae	<i>Cypseloides niger</i> , Black Swift
Tyrannidae	<i>Sayornis nigricans</i> , Black Phoebe <i>Pyrocephalus rubinus</i> , Vermilion Flycatcher
Hirundinidae	<i>Stelgidopteryx</i> , Rough-winged Swallow
Troglodytidae	<i>Troglodytes musculus</i> — House Wren
Vireonidae	<i>Vireo virescens</i> , Red-eyed Vireo and allies
Thraupidae	<i>Piranga flava</i> group, tanagers
Icteridae	<i>Cassidix major</i> , Great-tailed Grackle <i>Sturnella magna</i> , Meadowlark

Certain general comments on this list are in order. Nineteen of the families are of nearly world-wide distribution, whose locus of origin is unknown, and I agree with Dr. Mayr that there is no use guessing at it. In many cases the genus, and in most cases the species, is a distinct New World type, but in which secondary center of evolution it originated is also anybody's guess. Of more interest in this connection are the cases where even the species is cosmopolitan, or at least occurs in parts of the Old World, such as the gallinule (*Gallinula*

¹ Also *Asio flammeus*, the Short-eared Owl, as a visitor.

chloropus), the Barn and Short-eared Owls. The families Cathartidae, Aramidae, Tyrannidae, Troglodytidae, Vireonidae, Thraupidae, and Icteridae are New World families. A fossil record indicates a Middle American origin for the first two, a preponderance of genera and species suggests a Middle and Warm North American origin for the wrens and vireos. The tanagers are chiefly tropical and South American. The tyrant flycatchers and Icteridae are large families with peculiar genera and species in every faunal subdivision of the New World except the arctic.

A more detailed discussion of the genera and species involved in this list is outside the province of this paper. By definition the occurrence of these birds in Mexico is a matter of common sense, and is not due to any factors specially characteristic of Mexico, which favor them. Its central position and varied terrain suffice. In some cases not even the latter factor applies. The Turkey Vulture hunts for food over every portion of Mexico, the ocean beaches, the deserts, the tropical forests and the highest mountain peaks.

b) Widely ranging in most of the New World tropics.

<i>Colymbus dominicus</i>	Least Grebe
<i>Cochlearius cochlearius</i>	Boat-billed Heron
<i>Dendrocygna autumnalis</i>	Black-bellied Tree-duck
<i>Nomonyx dominicus</i>	Masked Duck
<i>Sarcorhamphus papa</i>	King Vulture
<i>Odontriorchis palliatus</i>	Snail-hawk
<i>Chondrohierax uncinatus</i>	do
<i>Buteo magnirostris</i>	
<i>Hypomorphnus urubitinga</i>	Black Hawk
<i>Busarellus nigricollis</i>	River Hawk
<i>Geranospiza nigra</i>	Crane Hawk
<i>Aramides cayanaea</i>	Wood Rail
“ <i>axillaris</i>	do
<i>Columbigallina talpacoti</i>	Ruddy Ground Dove
<i>Leptotila verreauxi</i>	White-fronted Ground Dove
<i>Oreopelia montana</i>	Ruddy Quail-Dove
<i>Amazona ochrocephala</i>	Yellow-crowned Parrot
<i>Coccyzus minor</i>	Mangrove Cuckoo
<i>Piaya cayana</i>	Squirrel-Cuckoo
<i>Tapera naevia</i>	Striped Cuckoo
<i>Crotophaga sulcirostris</i>	Groove-billed Ani
<i>Ciccaba virgata</i>	Brown Wood Owl
“ <i>nigrolineata</i>	Barred Wood Owl
<i>Rhynopteryx clamator</i>	Striped Horned Owl
<i>Glaucidium minutissimum</i>	Pygmy Owl
“ <i>brasilianum</i>	do

<i>Asio stygius</i>	Tropical Long-eared Owl
<i>Nyctibius griseus</i>	Potoo, a special New World family
<i>Chordeiles acutipennis</i>	Trilling Nighthawk
<i>Nyctidromus albigollis</i>	Parauque
<i>Streptoprocne zonaris</i> ¹	White-collared Swift
<i>Chaetura rutila</i> ¹	Chestnut-collared Swift
<i>Phaethornis superciliosus</i>	Hermit Hummingbird
<i>Chlorostilbon caniveti</i>	Emerald Hummingbird
<i>Helimaster longirostris</i>	do
<i>Ceryle torquata</i>	Ringed Kingfisher
<i>Chloroceryle amazona</i>	Green Kingfisher
“ <i>americana</i>	Little Green Kingfisher
<i>Piculus rubiginosus</i>	Green Woodpecker
<i>Dryocopus lineatus</i>	Tropical Pileated Woodpecker
<i>Veniliornis oleagineus</i>	Oily Woodpecker
<i>Muscivora tyrannus</i>	Fork-tailed Flycatcher
<i>Tyrannus melancholicus</i>	Couch's Kingbird
<i>Legatus leucophaeus</i>	
<i>Myiodynastes maculatus</i>	
<i>Megarhynchus pitangua</i>	Boat-billed Flycatcher
<i>Myiozetetes similis</i>	
<i>Pitangus sulphuratus</i>	Derby Flycatcher
<i>Myiarchus tyrannulus</i>	
“ <i>tuberculifer</i>	
<i>Myiochanes cinereus</i>	Gray Wood Pewee
<i>Elaina flavogaster</i>	
“ <i>viridicata</i>	
<i>Tityra semifasciata</i>	Family Cotingidae
<i>Progne chalybea</i>	Gray-breasted Martin
<i>Iridoprocne albilinea</i>	Mangrove Swallow
<i>Thryothorus rutilus</i>	Rufous-breasted Wren
<i>Polioptila plumbea</i>	Gnatcatcher, Family Sylviidae
<i>Dendroica petechia</i>	Mangrove Warbler
<i>Habia rubica</i>	Ant-Tanager
<i>Eucometis penicillata</i>	Crested Tanager
<i>Saltator coerulescens</i>	Gray Saltator
<i>Sporophila minuta</i>	Red-breasted Seed-eater
<i>Volatinia jacarina</i>	Glossy Seed-eater

This list of birds brings out several interesting points. The very great majority of the families are in *exactly the same* category as in the first list, but only six genera and one species occur in the Old World. Of the remaining genera, only twelve have other species which penetrate into temperate North America. We meet some new families for the first time. The Nyctibiidae or Potoos are an equatorial South

¹ Might be included in group a with equal propriety.

American family, only one species of which reaches Mexico and the West Indies. The Cotingidae are also primarily South American, and the number of genera and species rapidly decreases as we proceed northward in Central America. The three finches belong to a special New World subfamily, the Richmondininae, chiefly South American; the genera *Saltator* and *Sporophila* are also chiefly South American, and in both genera only one species each is endemic north of the Panama isthmus. The hummingbirds, Trochilidae, are in the same category as the Tyrannidae. We note, therefore, the strengthening of the strictly New World elements, and meet a South American element for the first time, a mere handful of aggressive species.

IV. The true Neotropical or South American Element.

a) Widely ranging throughout tropical America, but chiefly confined to *humid rain forest* areas on the eastern coast of Central America, absent or rare and local on the Pacific coast north of the Nicaraguan isthmus.

Family		
Tinamidae	<i>Tinamus major</i>	Great Tinamou
	<i>Crypturellus soui</i>	
Ardeidae	<i>Agamia agami</i>	Agami Heron
	<i>Tigrisoma lineatum</i>	Tiger Bittern
Ciconiidae	<i>Jabiru mycteria</i>	Jabiru
Accipitridae	<i>Harpagus bidentatus</i>	Tooth-billed Kite
	<i>Accipiter bicolor</i>	
	<i>Leucopternis albigollis</i>	White Hawk
	<i>Harpia harpyja</i>	Harpy Eagle
Columbidae	<i>Columba cayannensis</i>	Pigeon
	<i>Columbigallina minuta</i>	Least Ground Dove
	<i>Claravis pretiosa</i>	Blue Ground Dove
Psittacidae	<i>Ara macao</i>	Scarlet Macaw
	<i>Amazona autumnalis</i>	
	“ <i>farinosa</i>	
Cuculidae	<i>Dromococcyx phasianellus</i>	Pheasant-Cuckoo
Strigidae	<i>Lophostrix cristata</i>	
	<i>Pulsatrix perspicillata</i>	Spectacled Owl
Apodidae	<i>Panyptila cayannensis</i>	Fork-tailed Swift
Trochilidae	<i>Phoebastria longuemareus</i>	Hermit Hummer
	<i>Florisuga mellivora</i>	Jacobi Hummer
	<i>Thalurania furcata</i>	Purple Wood-Nymph
Trogonidae	<i>Trogon collaris</i>	Collared Trogon
	“ <i>violaceus</i>	
Alcedinidae	<i>Chloroceryle aenea</i>	Least Kingfisher
Momotidae	<i>Momotus momota</i>	Motmot

Bucconidae	<i>Notharchus hyperrhynchus</i>	Puff-bird
Formicariidae	<i>Taraba major</i>	Great Ant-shrike
	<i>Thamnophilus doliatus</i>	Barred Ant-shrike
	<i>Thamnistes anabatinus</i>	
	<i>Microrhopias quixensis</i>	Ant-Wren
	<i>Myrmotherula schisticolor</i>	Slaty Ant-Wren
	<i>Cercomacra tyrannina</i>	Tyrannine Ant bird
	<i>Formicarius analis</i>	Ant-Thrush
Furnariidae	<i>Automolus ochrolaemus</i>	
	<i>Xcnops minutus</i>	
	<i>Sclerurus mexicanus</i>	
Dendrocolaptidae	<i>Dendrocolaptes certhia</i>	Wood-hewer
	<i>Lepidocolaptes souleyetii</i>	
	<i>Glyphorhynchus spirurus</i>	
	<i>Sittasomus griseicapillus</i>	
Tyrannidae	<i>Platyrinchus mystaceus</i>	Flat-billed Flycatcher
	<i>Tolmomyias sulphurescens</i>	
	<i>Todirostrum cinereum</i>	Tody-Tyrant
	“ <i>sylvia</i>	
	<i>Leptopogon amaurocephalus</i>	
	<i>Pipromorpha oleaginea</i>	
Pipridae	<i>Schiffornis turdinus</i>	Thrush-like Manakin
Cotingidae	<i>Cotinga maynana</i>	Blue Cotinga
	<i>Attila spadiceus</i>	
	<i>Pachyramphus cinnamomeus</i>	
	<i>Tityra inquisitor</i>	
Troglodytidae	<i>Henicorhina leucosticta</i>	Black-capped Wood-Wren
Vireonidae	<i>Hylophilus ochraceiceps</i>	
	<i>Cyclarhis gujanensis</i>	Pepper Shrike
Coerebidae	<i>Cyanerpes cyaneus</i>	Blue Honey-creeper
	<i>Coereba flaveola</i>	Banana-quit
Thraupidae	<i>Tangara nigro-cincta</i>	Paradise Tanager
	<i>Thraupis episcopus</i>	Blue Tanager
Icteridae	<i>Amblycercus holosericeus</i>	Prevost's Cacique
	<i>Psomocolax oryzivorus</i>	Rice Grackle
	<i>Icterus mesomelas</i>	Oriole
Fringillidae	<i>Saltator maximus</i>	
	<i>Cyanocompsa cyanoides</i>	Blue Rice Grosbeak
	<i>Tiaris olivacea</i>	Seed-eater
	<i>Arremon aurantirostris</i>	Red-billed Sparrow
	<i>Arremonops conirostris</i>	Green Sparrow

b) Mexico to west Ecuador in humid tropical rain forest.

Family		
Cracidae	<i>Crax rubra</i>	Curassow
	<i>Penelope purpurascens</i>	Guan

Heliornithidae	<i>Heliornis fulica</i>	Sun-Grebe
Eurypygidae	<i>Eurypyga helias</i>	Sun-Bittern
Trochilidae	<i>Amazilia tzacatl</i>	
Galbulidae	<i>Galbula melanogenia</i>	Jacamar
Bucconidae	<i>Malacoptila panamensis</i>	Puff-bird
Furnariidae	<i>Sclerurus guatemalensis</i>	
Tyrannidae	<i>Myiobius sulphureipygius</i>	
	<i>Rhynchocyclus brevirostris</i>	
	<i>Microtriccus semiflavus</i>	
Pipridae	<i>Pipra mentalis</i>	Yellow-thighed Manakin
Cotingidae	<i>Lipaugus unirufus</i>	Piha Cotinga
Vireonidae	<i>Hylophilus decurtatus</i>	
Icteridae	<i>Zarhynchus wagleri</i>	Wagler's Oropendola
	<i>Icterus chrysater</i>	Oriole
Fringillidae	<i>Sporophila aurita</i>	Black and White Seed-eater
	<i>Oryzoborus funereus</i>	Black Rice Grosbeak

c) Mexico and Central America only, a few species reaching north Colombia in humid tropical rain forest.

Family		
Tinamidae	<i>Crypturellus boucardi</i>	Boucard's Tinamou
Phasianidae	<i>Odontophorus guttatus</i>	Spotted Partridge
Columbidae	<i>Columba nigrirostris</i>	Black-billed Pigeon
	<i>Leptotila plumbeiceps</i>	
	“ <i>cassini</i>	
Psittacidae	<i>Aratinga astec</i>	Aztec Parrakeet
	<i>Pionopsitta haematotis</i>	Red-eared Parrot
	<i>Pionus senilis</i>	White-headed Parrot
Trochilidae	<i>Anthracothorax prevosti</i>	Mango Hummer
	<i>Paphosia helenae</i>	Coquette Hummer
	<i>Hylocharis eliceae</i>	
	<i>Amazilia candida</i>	
Momotidae	<i>Hylomanes momotula</i>	Tody Motmot
	<i>Electron carinatus</i>	Green Motmot
Trogonidae	<i>Trogon massena</i>	Massena Trogon
Ramphastidae	<i>Ramphastos piscivorus</i>	Toucan
	<i>Pteroglossus torquatus</i>	Collared Toucan
Picidae	<i>Celeus castaneus</i>	Chestnut Woodpecker
Dendrocolaptidae	<i>Dendrocincla homochroa</i>	
	“ <i>anabatina</i>	
Tyrannidae	<i>Onychorhynchus mexicanus</i>	Royal Flycatcher
Pipridae	<i>Manacus candei</i>	Bearded Manakin
Vireonidae	<i>Smaragdolanus pulchellus</i>	Emerald Vireo
Thraupidae	<i>Tanagra lauta</i>	Bonaparte's Euphonia
	“ <i>gouldi</i>	Gould's Euphonia
	<i>Ramphocelus passerinii</i>	Crimson-rumped Tanager

	<i>Phlogothraupis sanguinolentus</i>	Crimson-collared Tanager
	<i>Habia gutturalis</i>	Ant-Tanager
	<i>Lanio aurantius</i>	Black and Yellow Tanager
Icteridae	<i>Gymnostinops montezuma</i>	Chestnut Oropendola
	<i>Icterus prothemelas</i>	Oriole
Fringillidae	<i>Saltator atriceps</i>	
	<i>Caryothraustes poliogaster</i>	Black and Yellow Grosbeak

d) Widely ranging throughout tropical America, chiefly in humid rain forest, but in the Subtropical¹ or even the Temperate Zone.

Family		
Columbidae	<i>Claravis mondelourea</i>	Ground Pigeon
	<i>Oreopeleia linearis</i>	Quail-Dove
Psittacidae	<i>Bolborhynchus lineola</i>	Barred Parrakeet
Strigidae	<i>Otus guatemalae</i>	Screech Owl
Trochilidae	<i>Colibri thalassinus</i>	Violet-eared Hummer
	² <i>Campylopterus hemileucurus</i>	Purple Sabre-wing
Trogonidae	<i>Pharomachrus mocinno</i>	Paradise Trogon; Quetzal
Ramphastidae	<i>Aulacorhynchus prasinus</i>	Green Toucanet
Formicariidae	<i>Grallaria guatemalensis</i>	Ant-Pitta
Furnariidae	<i>Xenicopsoides montanus</i>	
	<i>Automolus rubiginosus</i>	Ruddy Automolus
Dendrocolaptidae	<i>Dendrocolaptes picumnus</i>	Wood Hearer
	<i>Xiphocolaptes promeropirhynchus</i>	Red-billed Wood Hearer
	² <i>Lepidocolaptes affinis</i>	Reaches sea level in N. E. Mexico
Tyrannidae	<i>Mitrephanes phaeocercus</i>	Crested Pewee
Troglodytidae	<i>Henicorhina leucophrys</i>	White-browed Wood-Wren
Turdidae	² <i>Turdus ignobilis</i>	Dusky Robin
	³ <i>Myadestes unicolor</i>	Slaty Solitaire
Coerebidae	<i>Diglossa baritula</i>	
Parulidae	<i>Myioborus miniatus</i>	Tropical Redstart
	<i>Basileuterus culicivorus</i>	
Thraupidae	² <i>Chlorophonia occipitalis</i>	Emerald Euphonia
	<i>Piranga leucoptera</i>	White-winged Tanager
	<i>Chlorospingus ophthalmicus</i>	
Fringillidae	<i>Spodiornis rusticus</i>	
	<i>Atlappes gutturalis</i>	Yellow-throated Sparrow
	“ <i>brunneiucha</i>	
	“ <i>torquatus</i>	

This long list of birds, divided into four sections, brings out many interesting points:

¹ Many people prefer the term upper Tropical.

² Ranging from Mexico to western Panama only.

³ Ranging from Mexico to northern Nicaragua only.

Total number of families represented	33
Chiefly tropical American	6
" South American	12
Total number of genera represented	130
Cosmopolitan	4
New World	6
Tropical American	21
South American	99

Only one genus is restricted to Central America, the tanager, *Phlogothraupis*, based on minor technicalities. In marked contrast to the last list, Group III b, the South American element is overwhelmingly preponderant.

A study of the species involved yields further evidence, using those belonging to the primarily South American genera.

Total number of such species in Mexico	148
Ranging from Mexico — Amazonia	90
" " " — Ecuador west of the Andes	18
" " " — Panama or north Colombia	37
Endemic in Mexico and northern Central America	1

It must be born in mind that the ninety-nine genera involved have some two thousand species in South America, and that the primarily South American families possess at least two hundred other genera. It should be clear that only a mere tinge of this South American avifauna has penetrated north to southern Mexico. In only thirty-eight cases has specific change taken place north of the Colombian Andes, and further exploration will undoubtedly reduce some of them to subspecies. Of the eighty-nine widely ranging species, no less than thirty-six decrease rapidly northward in Central America, and they are so rare in southern Mexico, that in several cases only 1-3 specimens have ever been collected. The table below considers a great South American family, the Formicariidae or Ant-birds, and shows graphically how it decreases northward in Central America, in spite of the continuity of the rain forest. All the larger South American families would show precisely similar results.

Formicariidae	Genera	Species
Total number known	55	233
Ranging north to western Panama	18	27
" " " Nicaragua	17	21
" " " Guatemala	11	11
" " " Mexico	8	8

We should now recall that during the period of extreme Pleistocene glaciation, the humid tropical forests must have been far south of their present limits, which were attained or regained with the arrival of less rigorous conditions. At the same time the upper Tropical Zone, at least, descended to sea level, and the birds again reascended the mountains, thus accounting for their present discontinuous distribution. To sum up, the accumulated evidence fully justifies the hypothesis that some of the birds at least in Group IV, must represent a recent invasion from the south. The ancestors of some of them may well have originated in far earlier geological eras in North America (Cracidae and Aramidæ, for instance) and reached South America in Eocene time or by hopping the Central American Islands during the Tertiary, but South America has clearly been their major evolutionary center, from which a small percentage have radiated northward from late Tertiary time on, with little or no evolutionary change.

The next element in the avifauna of Mexico is a very small but particularly interesting one. A small group of species peculiar to middle America, and chiefly in the arid tropical Pacific lowlands, have no near allies. Another group of relict species provide cases of a remarkable degree of discontinuous distribution, or else they have been left stranded, as it were, in Mexico or Central America, while their relations moved southward, and developed along other lines. Each case requires treatment in considerable detail; otherwise only an expert in tropical American birds would get the point.

V. Preglacial relicts, which have been in Mexico a very considerable length of time. Endemics are marked with an asterisk; the term is used in a faunal, not a political sense.

a) Species of limited range, but never restricted to humid tropical rain forest, and commonest in or confined to the arid tropics. Endemic species marked with an asterisk.

Family		
Tinamidae	<i>Crypturellus cinnamomeus</i>	Mexico to N. W. Costa Rica, chiefly in the arid tropical zone on the Pacific Slope
Ardeidae	<i>Heterocnus cabanisi</i>	Mexico to Panama, on both coasts
Cracidae	<i>Ortalis vetula</i>	U. S. A. to Nicaragua, in arid and humid tropics
	* <i>Ortalis wagleri</i>	Arid tropics of west Mexico
Psittacidae	<i>Aratinga canicularis</i>	W. Mexico to N. W. Costa Rica, arid tropics

	<i>Amazona albifrons</i>	Mexico to N. W. Costa Rica
	* <i>Amazona xantholora</i>	Arid portion of Yucatan Peninsula
Picidae	<i>Phlaeoceastes guatemalensis</i>	Mexico to Panama, both coasts
Tyrannidae	<i>Oncostoma cinereigulare</i>	Mexico to W. Panama, chiefly arid tropics
Pipridae	<i>Chiroxiphia linearis</i>	W. Mexico to N. W. Costa Rica, arid tropics
Cotingidae	<i>Pachyramphus major</i>	N. W. and N. E. Mexico to Nicaragua, in both tropics and mountains
	<i>Platypsaris aglaiae</i>	U. S. border to Costa Rica, in both arid and humid tropics and the mountains
Troglodytidae	<i>Heleodytes zonatus</i>	Mexico to W. Panama, reap- pearing in W. Ecuador; vari- ously in arid and humid tropics and mountain pine forests
	<i>Thryophilus modestus</i>	Mexico to W. Panama, arid tropics
	" <i>pleurostictus</i>	Mexico to N. W. Costa Rica, arid tropics
Turdidae	<i>Turdus assimilis</i>	Mexico to N. Colombia, arid and humid tropics
	<i>Turdus grayi</i>	Mexico to N. Colombia, arid and humid tropics
Parulidae	<i>Euthlypis lachrymosa</i>	Mexico to Costa Rica, arid tropics
Thraupidae	* <i>Tanagra godmani</i>	Arid tropics of W. Mexico
	" <i>affinis</i>	W. Mexico to N. W. Costa Rica, arid tropics
	<i>Thraupis abbas</i>	Mexico to Nicaragua, chiefly arid tropics
Fringillidae	<i>Sporophila torqueola</i>	Mexico to Costa Rica, arid and humid tropics
	<i>Arremonops rufivirgatus</i>	Mexico to Costa Rica, chiefly arid tropics
	<i>Cyanocopsa parellina</i>	A very distinct species of an otherwise South American genus, chiefly in the arid tropics of Mexico and northern Central America

This list could be greatly extended by adding other species from the Pacific coast of Central America, which do not range north into Mexico.

Readers should notice, at once, that five of the families represented are world-wide in distribution, of great antiquity in the New World, and there need be no surprise that endemic species have been evolved

in so marked an ecological niche as the arid tropical lowlands of Middle America. Two of the genera, *Heterocnus* and *Euthlypis*, are endemic. The New World families are either primarily South American, or if not, the genera represented are. In these cases the species is so distinct as to have no obvious relations further south. The only exception is *Crypturellus cinnamomeus*, now stranded in its present range, cut off from relatives in west Ecuador and the Orinoco Valley. It is, therefore, my conviction that these species originated in preglacial time in the general area where they are now found, and by one means or another survived the Ice Age.

In addition to this historical factor there is a most important ecological one, which has never been brought out.

1. The humid tropical rain forest on the eastern coastal plain of Mexico and Central America requires eighty to two hundred plus inches of rain, distributed *throughout the year*, to develop. It is absolutely continuous, crosses the continent at the Isthmus of Panama, and extends into South America on both the Pacific and Caribbean coasts. It follows that all more aggressive types of birds can wander north or south as they please, remaining in a uniform environment.

2. The arid tropical zone of the Pacific lowlands has a rainfall of twenty-five to eighty inches a year in a pronounced wet season, followed by a *prolonged dry season*. According to the amount of rain, either a scrub forest or a high gallery forest is produced. Rain shadows caused by the central mountain masses divide the Pacific lowlands into sharply contrasting belts of scrub and gallery forest, and the birds partial to each are, therefore, isolated in a series of ecological islands. Ecological discontinuity is consequently the outstanding characteristic of the Pacific coastal plain of middle America. The net result is a large number of endemic species, of very limited range. Only *one* bird, the Parrakeet, *Brotogerys jugularis*, all the other members of the genus being South American, has the distinction of ranging continuously from Amazonia up the Pacific coast of America to Chiapas.

All these points will receive renewed emphasis when we examine the group of "relict" birds which come next. The two groups are not sharply differentiated, and several of the species belong as well in one list as the other. Note that only one of the birds in the list which follows is confined to humid tropical rain forest.

b) Preglacial Relicts

The term "relict", as constantly used by the zoogeographer, requires definition, since it is not the current one in the dictionary. It implies a species of animal of very limited range, so widely separated from

close relatives that the usual reasons for discontinuous distribution do not apply or do not satisfactorily explain it. These usual reasons are obviously 1) the required climate is discontinuous. 2) the required habitat is discontinuous, or 3) both are discontinuous. Unknown, unfavorable factors in the past history of species or genus are, therefore, implied and presumed; they became extinct in the intermediate area. These relicts are, therefore, in the same category as the relict animals of the palaeontologist, but the fossil record to prove it is lacking. Thus the two living species of elephants, and tapirs in tropical America, are relicts of once abundant and widely distributed groups, particularly in North America. But while the survival of the tapirs in South America is so easily understandable as almost to be a matter of common sense, I doubt if even the palaeontologist can suggest why elephants did not survive also.

Let us consider the little parrots of the genus *Forpus*, which live in the arid and humid tropics and subtropics of South America. It is impossible to see why they should not range over most of Central America also. Since the same fact, however, is true of innumerable other genera, we infer that they originated in South America, and have not been sufficiently aggressive to push northward, after the Central American land bridge became available in the late Tertiary. This theory is demolished by the discovery of a distinct species, *F. cyanopygius*, in the arid tropical coastal plain of northwestern Mexico. Moreover a study of this bird in its native environment makes it impossible to understand why it does not occupy the whole Pacific coast of Mexico, or for that matter the arid tropics of Central America. Similarly the recently discovered tufted jay, *Cyanocorax dickeyi*, in a mountain range in Sinaloa, occurs at an altitude and in a type of montane forest widely distributed in western, central and southern Mexico, and all its associated species are widely distributed.

Non-ornithological readers must, therefore, assume the existence of similar unexplainable factors in the list of birds which follows.

Family Cracidae — of middle or warm North American origin, now widely distributed, chiefly South American.

**Oreophasis* — A remarkable genus in the high mountains of Chiapas and Guatemala, sometimes regarded as a special subfamily.

**Penelopina* — Endemic in the Subtropical Zone of Chiapas south to northern Nicaragua.

Family Burhinidae — an old, relict group of Shore birds with a very wide but interrupted distribution.

Burhinus bistriatus — locally in savannas on the Pacific Slope of Mexico and Central America, reappearing in Ecuador and Peru.

Family Psittacidae

Ara militaris is common in the mountains of Mexico, reappearing in the Andes from Colombia to Bolivia.

Aratinga holochlora ranges from northwestern Mexico to Nicaragua. It is a zonally inconstant species, characteristic of the arid tropics of the Pacific lowlands, but also widely scattered in montane pine forests. It has no near relative in the genus and furnishes an ideal illustration of a bird which defies ecological classification.

**Forpus cyanopygius*, a species of northwestern Mexico, chiefly in the arid tropics. The genus reappears in South America, where numerous species are widely distributed in both the arid and humid tropics.

**Amazona viridigenalis* is endemic in northeastern Mexico, chiefly in the Tamaulipan Biotic Province. Its nearest relative is

**Amazona finschi*, endemic in western Mexico in the arid tropics. Other species range widely throughout tropical America.

Recalling the endemic genus *Rhynchopsitta* (p. 368) and the extinct *Conuropsis* of the U. S. (Miocene time-Recent), the Old Northern or North American origin of New World Parrots is suggested.

Family Caprimulgidae — world wide, of unknown origin.

Caprimulgus maculicaudus — recently discovered in Oaxaca, is widely distributed in tropical South America.

Family Apodidae — world wide, but chiefly tropical; of unknown origin.

**Streptoprocne senicollaris* — a very rare species of the mountains of Central Mexico. Another species is widely distributed throughout the New World in tropical latitudes. A third is in eastern Brazil.

Family Trochilidae — a remarkable pan-American group with many centers of evolution.

**Campylopterus curvipennis* — restricted to tropical southeastern Mexico and Guatemala. Related to *largipennis* of eastern South America.

**Campylopterus rufus* — endemic in the mountains of Guatemala, its only relative, *hyperythrus*, on the summit of Mt. Roraima.

Amazilia rutila — arid tropical zone of Mexico and Central America.

**Amazilia yucatanensis* — its closest relative, on the Caribbean slope from Texas to British Honduras. Two very distinct species in a large and varied pan-tropical genus.

Helimaster constantii — a very distinct species of the arid tropical zone of Mexico and northern Central America. Other species reappear in southeastern Brazil.

Family Trogonidae — a pan-tropical family, with a marked center of development and evolution in middle or warm North America.

Trogon citreolus and *melanocephalus* — tropical zone, chiefly arid, in Mexico and northern Central America.

**Trogon mexicanus* — temperate zone, chiefly in mountain pine forest, Mexico to Honduras.

Trogon elegans — zonally inconstant, from southern Arizona to Costa Rica; some subspecies in mountain pine forests, others in the arid tropics.

Family Momotidae — a family of warm or middle North American origin, only a few elements of which have reached South America.

**Aspatha gularis* — an endemic genus of the mountains of southern Mexico to Honduras, chiefly in oak forests.

Eumomota superciliaris — a monotypic genus, endemic in the arid tropics from southern Mexico to Costa Rica.

**Momotus mexicanus* — arid tropical zone, western Mexico and the interior desert of Guatemala.

Family Furnariidae — a vast family, primarily developed in South America, with a steadily diminishing number of genera and species as we proceed northward in Central America.

Synallaxis erythrorhox — a distinct species of southern Mexico and northern Central America, related to a group of South American species, unrepresented in southern Central America.

Family Dendrocolaptidae — for comments see preceding family.

Xiphorhynchus flavigaster — chiefly arid tropical zone in southern Mexico to Costa Rica. Its only close relative in a large South American genus is

**X. striatigularis* — known from only one specimen from southern Tamaulipas.

**Lepidocolaptes leucogaster* — a peculiar species confined to western Mexico, in the arid tropical and subtemperate zones, very different from all other species of a large South American genus.

Family Hirundinidae — one of the few distinct families of oscine Passeres, of world-wide distribution and unknown origin.

Petrochelidon fulva — a relict species with a remarkably interrupted distribution, the Greater Antilles, northeastern Mexico and Texas, Yucatan, west Ecuador and Peru.

Family Corvidae — of world-wide distribution, but with an important center of development in middle and warm North America; very few members have reached South America.

**Cyanocorax dickeyi* — a remarkable recent discovery, known from a high mountain range in Sinaloa. Other species referred to this genus are South American, one ranging north into southern Central America.

Xanthoura yncas — the Green Jay (a very poor monotypic genus) is common in the arid and humid tropics of Mexico, Guatemala and northern Honduras. It reappears in the Subtropical zone of the Andes from Colombia and Venezuela to Bolivia.

Family Troglodytidae — a New World family with an important evolutionary center in warm North America, and another in South America.

**Hylorchilus sumichrasti* — a very rare bird restricted to three known localities in the tropical rain forests of Vera Cruz. Its relatives are *Leucolepis* and *Microcerculus*, which are primarily Amazonian genera.

Family Mimidae — a New World group, with several centers of evolution in Middle America, very few reaching South America.

Mimus gilvus — distribution curiously disconnected; Lesser Antilles, northern South America, also southeastern Mexico to eastern Honduras

Family Turdidae — a nearly cosmopolitan family, with several centers of differentiation in the New World.

**Turdus infuscatus* — humid temperate zone in the mountains of southern Mexico to Honduras. One of a group of "all black" species scattered in high mountains south to Argentina.

Family Parulidae — a New World family of middle or warm North American origin, very few genera reaching South America.

**Granatellus venustus*.

**G. sallaei* — two rare and local species of the tropical zone of southwestern and southeastern Mexico and Peten. The genus reappears in Amazonia.

Family Thraupidae — a New World family richly developed in South America, the number of genera and species rapidly decreasing northward in middle America.

Tanagra elegantissima — mountains of southern Mexico to western Panama. One of a group of "blue capped" species, reappearing in the Andes and the West Indies.

**Tangara cabanisi* — known from only two specimens from Chiapas and western Guatemala, humid tropical zone of Pacific Slope; most closely related to *T. palmeri* of western Colombia. A vast genus of South America, very few species ranging north into middle America.

Rhodinocichla rosea — a monotypic genus of uncertain family affinities, locally in the tropics of western Mexico, reappearing in western Panama, and again on the coast of Colombia and Venezuela.

Family Icteridae — a characteristic New World family, with numerous centers of development.

**Cassiculus melanicterus* — a monotypic genus of the arid tropics of western Mexico, belonging to a large group of "hang-nests" or caciques, primarily South American, chiefly in rain forest.

Dives dives — a monotypic genus, zonally quite inconstant in southern Mexico to Nicaragua, reappearing in western Ecuador and Peru.

Family Fringillidae — the largest family of birds, absent in Australia. There are three well marked subfamilies, but unfortunately too many of the tropical American genera cannot as yet be assigned, for lack of the proper anatomical studies. One subfamily, Richmondeninae, is primarily South American, the Emberizinae are primarily North American, and the Carduelinae are primarily Old World and Boreal.

Pheucticus chrysopheplus — a species of the arid tropics of western Mexico and Guatemala, which reappears in South America from Colombia to Peru.

**Rhodothraupis celaeno* — a monotypic genus of the Tamaulipan Biotic Province. Its closest relative is *Periporphyrus* of the Guianas.

**Amaurospizopsis relictus* — a very rare monotypic genus in the mountains of Guerrero, is very closely related to the rare *Amaurospiza*, which is found in the humid tropics of Central America, west Ecuador, and Brazil.

Sicalis luteola — a very common finch throughout South America, reappears as a very rare bird in the high mountains of southern Mexico and Guatemala.

**Atlapetes pileatus* — a genus of innumerable species in South America scarcely any northward. The present species of the Mexican Plateau is very distinct.

Atlapetes albinucha — a species of the mountains of southern Mexico, reappearing in Colombia without even racial variation!

Comparative Table for Humid and Arid Tropical Lowlands Species

	Caribbean	Pacific
Common to both.....	154	154
Mexico to South America.....	107	1
Endemic, Central America to Mexico.....	38	52
Endemic, Mexico and Guatemala.....	0	19

As we shall see later, the apparent poverty of the avifauna of the Pacific coast of Mexico and Central America, is compensated for by many endemic genera and species of middle or warm North American (old Northern) affinities, which have entered the present tropical lowlands.

VI. Old Northern Element, the existing species and genera, of the present, characteristically middle or warm North American.

a) Primarily or presumably middle North American in origin and range."

1) Breeding in some part of Mexico at least.

Family		
Anatidae	<i>Erismatura jamaicensis</i>	Ruddy Duck
Accipitridae	<i>Accipiter cooperi</i>	Cooper's Hawk
	" <i>striatus</i>	Sharp-shinned Hawk
	<i>Buteo lineatus</i>	Red-shouldered Hawk
Falconidae	<i>Falco mexicanus</i>	Prairie Falcon
Meleagrididae	<i>Meleagris gallopavo</i>	Wild Turkey
Rallidae	<i>Coturnicops noveboracensis</i>	Yellow Rail
Charadriidae	<i>Oxyechus vociferus</i>	Killdeer Plover
	<i>Pagolla wilsonia</i>	Wilson's Plover
Laridae	<i>Larus occidentalis</i>	Western Gull
	" <i>atricilla</i>	Laughing Gull
Cuculidae	<i>Coccyzus americanus</i>	Yellow-billed Cuckoo
Strigidae	<i>Otus asio</i>	Screech Owl
	<i>Glaucidium gnoma</i>	Pygmy Owl
Caprimulgidae	<i>Caprimulgus vociferus</i>	Whippoorwill
Apodidae	<i>Chaetura vauxi</i>	Vaux's Swift
Tyrannidae	<i>Myiochanes virens</i>	Wood Pewee
	<i>Empidonax difficilis</i>	Western Flycatcher

Family		
Hirundinidae	<i>Progne subis</i>	Purple Martin
	<i>Petrochelidon pyrrhonota</i>	Cliff Swallow
	<i>Tachycineta thalassina</i>	Violet-green Swallow
Corvidae	<i>Corvus brachyrhynchos</i>	American Crow
	<i>Cyanocitta stelleri</i>	Steller's Jay
	<i>Cyanocephalus</i>	Pinon Jay
	<i>Cinclus mexicanus</i>	American Dipper
Cinclidae	<i>Cinclus mexicanus</i>	American Dipper
Troglodytidae	<i>Thryothorus ludovicianus</i>	Carolina Wren
	<i>Thryomanes bewickii</i>	Bewick's Wren
	* " <i>insularis</i>	Socorro Isl. Wren
	<i>Cistothorus platensis</i>	Short-billed Marsh Wren
Mimidae	<i>Mimus polyglottos</i>	Mockingbird
Turdidae	<i>Turdus migratorius</i>	American Robin
	<i>Sialia sialis</i>	Bluebird
Vireonidae	<i>Vireo griseus</i>	White-eyed Vireo
	" <i>solitarius</i>	Blue-headed Vireo
	" <i>gilvus</i>	Warbling Vireo
	<i>Parula pitaiyumi</i>	Pitaiyumi Warbler
Parulidae	<i>Dendroica auduboni</i>	Audubon's Warbler
	<i>Geothlypis trichas</i>	Northern Yellow-throat
	<i>Piranga rubra</i>	Summer Tanager
Thraupidae	<i>Piranga ludoviciana</i>	Western Tanager
	<i>Molothrus ater</i>	Cowbird
	<i>Icterus spurius</i>	Orchard Oriole
Icteridae	<i>Agelaius phoeniceus</i>	Red-winged Blackbird
	<i>Hedymeles melanocephalus</i>	Black-headed Grosbeak
	<i>Ammodramus savannarum</i>	Grasshopper Sparrow
	<i>Passerculus sandwichensis</i>	Savanna Sparrow
	<i>Junco oregonus</i>	Oregon Junco
	<i>Spizella passerina</i>	Chipping Sparrow
	<i>Zonotrichia capensis</i>	Chingolo Song Sparrow
	<i>Melospiza melodia</i>	Song Sparrow

2) Migrants, and winter visitors, breeding in temperate or middle North America.

Western Grebe	Nighthawk
White Pelican	<i>Caprimulgus</i> , Chuck-will's-widow
American Bittern	Chimney Swift
Wood Duck	Belted Kingfisher
Hawks (<i>Buteo</i> , 3 species)	Picidae, Sapsucker
King Rail	Tyrannidae, 11 species
Shore Birds (Limicolae), 7 species	Swallows, 2 species
Laridae, 3 species	Wrens, 2 species
Passenger Pigeon	Mimidae, Catbird and Sage Thrasher
Black-billed Cuckoo	Thrushes, 8 species

Sprague's Pipit	Icteridae, 5 species
Cedar Waxwing	Fringillidae:
Vireos, 2 species	Richmondininae, 4 species
Parulidae (Wood Warblers), 34 species	Carduelinae, <i>Spinus</i> , 2 species
Scarlet Tanager	Emberizinae, 15 species

Readers should note the following points:

1. Every species is endemic in temperate North America, regardless of genus or family; the great majority are migratory. Only one is restricted to Mexico.

2. No less than 46 genera, and one family, the turkeys or Melagrididae, are endemic.

3. Ten families are now primarily tropical in distribution, and every species involved is highly migratory, wintering in the tropics. The only exceptions are the two Phoebe of the genus *Sayornis*, a Tyrannid genus, whose relatives are all in temperate South America.

4. The northern limits of all these birds must have been shrunk by 800–1000 miles at the period of maximum Pleistocene refrigeration, and their present ranges represent a recapture of a great extent of territory.

5. Only ten species range south of Mexico for varying distances in the mountains of Central America, or the Andes (*Cistothorus platensis* only).

6. Only 6 species have penetrated into tropical climates south of the Mexican tableland, where they have evolved distinct subspecies. Only two species, *Parula pitiayumi* and *Zonotrichia capensis* are now widely distributed in South America (cf. Chapman, 1925, 1940).

7. Only two of the endemic genera, *Junco* and *Thryomanes*, have endemic species on the highest mountain peaks of Costa Rica, the avifauna of which is in part old North American.

b) Endemic genera and species, chiefly confined to Mexico, adjacent parts of Central America and the adjacent southwestern United States. Endemic genera are marked with an asterisk, and specific names are omitted in monotypic genera.

Family

Anatidae	<i>Anas diazi</i> , Mexican Black Duck
Cathartidae	* <i>Gymnogyps californianus</i> , California Condor
Phasianidae, Odontophorinae, New World only	
	* <i>Dendrortyx</i> , all 3 species of Tree-Quail, one south to the mountains of Costa Rica
	* <i>Oreortyx</i> , Mountain Quail
	* <i>Callipepla</i> , Scaled Quail

Family	<i>*Lophortyx</i> , all 3 species, one arid tropical
	<i>*Philortyx</i>
	<i>Colinus virginianus</i> , 14 subspecies out of some 17, some arid tropical
	<i>Colinus nigroregularis</i> , arid tropical. Bob-White
	<i>*Dactylortyx</i>
	<i>*Cyrtonyx</i> , both species of Ocellated Quail
Melcagrididae	<i>*Agriocharis</i> , Ocellated Turkey, arid tropical
Laridae	Heermann's Gull and Elegant Tern
Columbidae	<i>Columba flavirostris</i> , Red-billed Pigeon
	<i>Zenaidura graysoni</i> , Socorro Isl. Mourning Dove
	<i>Scardafella inca</i> , Inca Dove
Psittacidae	<i>*Rhynchopsitta</i> , 2 species in mountain pine forest. Thick-billed Parrots
Cuculidae	<i>*Geococcyx</i> , both species of Road-runner
	<i>Morococcyx</i> , arid tropical
Strigidae	<i>Otus</i> , 4 species, one arid tropical. Screech Owls
	<i>*Micrathene</i> , Elf Owl
Caprimulgidae	<i>*Otophanes</i> , both species of Eared Poor-wills
	<i>Caprimulgus</i> , 2 species, both arid tropical
Apodidae	<i>*Aeronautes</i> , White-throated Swift
Trochilidae	<i>*Cynanthus</i> , both species
	<i>Hylocharis</i> , 2 species
	<i>Amazilia</i> , 3 species
	<i>*Eupherusa</i> , 2 species; others in mountains of Costa Rica and W. Panama
	<i>*Lampornis</i> , 3 species; others in mountains of Costa Rica and W. Panama
	<i>*Lamprolaima</i>
	<i>*Eugenes</i> , also in mountains of Costa Rica
	<i>*Doricha</i>
	<i>*Tilmatura</i>
	<i>*Colothorax</i> , both species
	<i>*Abcillia</i>
	<i>*Archilochus colubris</i> , migratory, in eastern U. S.
	<i>*Archilochus alexandri</i>
	<i>Calypte</i> , 2 species
	<i>*Stellula calliope</i> , migratory northward in U. S.
	<i>*Atthis</i>
	<i>*Selasphorus</i> , 3 species, 2 migratory northward in U. S.; others in high mountains of Costa Rica
Trogonidae	<i>*Euphilotis</i> , Eared Trogon
Picidae	<i>Colaptes</i> , 3 species of Flicker
	<i>Centurus</i> , 5 species, several in arid tropics
	<i>Melanerpes formicivorus</i> , south to the mountains of Costa Rica

Family	<i>Campephilus imperialis</i> , Imperial Ivory-billed Woodpecker
	<i>Dendrocopos</i> , 4 species
Tyrannidae	<i>Muscivora forficata</i> , migratory northward in U. S.
	<i>Tyrannus</i> , 3 species, 1 arid tropical, 2 migratory in the U. S.
	<i>Myiodynastes luteiventris</i> , migratory
	<i>Myiarchus</i> , 4 species, 3 arid tropical, 1 migratory
	* <i>Deltarhynchus</i>
	<i>Myiochanes pertinax</i> , migratory northward
	* <i>Aechmolophus</i>
	<i>Empidonax</i> , 5 species, 2 migratory northward
	* <i>Xenotriccus</i>
	<i>Camptostoma imberbe</i> , Beardless Flycatcher
Hirundinidae	* <i>Progne sinaloae</i> , Sinaloa Martin
	<i>Atticora pileata</i> , Coban Swallow
Corvidae	<i>Corvus cryptoleucus</i> and <i>imparatus</i> , White-necked Raven and Mexican Crow
	* <i>Calocitta</i> , Magpie-Jay, arid tropics
	* <i>Psilorhinus</i> , both species, arid and humid tropics.
	Brown Jay
	* <i>Cissilopha</i> , all 4 species, 3 in arid tropics
	<i>Cyanolyca</i> , 4 species, also in mountains of Costa Rica
	* <i>Aphelocoma</i> , all 3 species, 1 subspecies isolated in Florida
Paridae	<i>Parus</i> , 4 species of Chickadee
	* <i>Auriparus</i> , Verdin
	* <i>Psaltriparus</i> , Bush-tit
Troglodytidae	<i>Heleodytes</i> , 6 species, some arid tropical. Cactus Wrens
	<i>Thryothorus</i> , 3 species, partly arid tropical
	<i>Troglodytes</i> , 3 species, one arid tropical
	* <i>Nannorchilus</i> , Short-tailed Wren
	* <i>Salpinctes</i> , Roek Wren
	* <i>Catherpes</i> , Canyon Wren
Mimidae	<i>Toxostoma</i> , 9 species, one other in eastern U. S.
	Thrashers
	* <i>Melanotis</i> , both species
	* <i>Melanoptila</i> , arid tropics, Yucatan and Cozumel Isl.
	Black Catbird
	* <i>Mimodes</i> , confined to Socorro Isl.
Turdidae	<i>Turdus</i> , 2 species of Robin
	<i>Myadestes obscurus</i> , a Solitaire
	<i>Catharus</i> , 5 species
	* <i>Ridgwayia</i>
	<i>Sialia mexicana</i> , Chestnut-backed Bluebird
Sylviidae	<i>Poliophtila</i> , 3 species, 1 migratory subspecies in eastern U. S. Gnatcatchers

Family	
*Ptilonotidae	* <i>Ptilonotus</i> , both species * <i>Phainopepla</i> N.B. The remaining genus, <i>Phainoptila</i> , in the high mountains of Costa Rica.
Vireonidae	<i>Vireo</i> , 9 species, some in U. S. migratory * <i>Neochloe</i> * <i>Vireolanus</i> , Shrike-Vireo
Parulidae	<i>Vermivora</i> , 4 species, 3 migratory * <i>Peucedramus</i> , Olive Warbler, migratory northward <i>Dendroica</i> , 2 species <i>Geothlypis</i> , 5 species * <i>Chamaethlypis</i> , south to Costa Rica * <i>Cardellina</i> , Red-faced Warbler <i>Setophaga picta</i> , Painted Redstart * <i>Ergaticus</i> , both species of Pink Warblers <i>Basileuterus</i> , 2 species
Thraupidae	<i>Piranga</i> , 3 species, 2 in arid tropics. Tanagers
Icteridae	<i>Tangavius aeneus</i> , Red-eyed Cowbird <i>Cassidix</i> , 2 species, 1 subspecies in eastern U. S. Great-tailed Grackles <i>Icterus</i> , 12 species, several in arid tropics. Orioles <i>Agelaius tricolor</i> , Tricolored Red-wing
Fringillidae	<i>Richmondia cardinalis</i> , 13 out of 17 subspecies, several in arid tropics. Cardinal * <i>Pyrhuloxia</i> * <i>Guiraca caerulea</i> , 1 subspecies in eastern U. S. Blue Grosbeak <i>Passerina</i> , 4 species, one migratory in U. S., and arid tropics <i>Spinus</i> , 3 species of Siskin <i>Pipilo</i> , 5 species of Towhee * <i>Melospiza</i> , all 4 species, one south to Costa Rica * <i>Plagiospiza</i> , Striped Sparrow * <i>Xenospiza</i> <i>Aimophila</i> , 11 species, several in arid tropics, one south to Costa Rica * <i>Amphispiza</i> , both species, Desert Sparrows <i>Junco phaeonotus</i> , Yellow-eyed Junco <i>Spizella</i> , 2 species

First of all I hasten to repeat an earlier caution on taxonomic points. Future study will reduce the number of genera (already proposed in some of the jays), and some of the species, notably in *Helodytes* and *Aimophila*. Another caution on an earlier page must also be repeated. The term, endemic, is used in a faunal sense, not a strictly political one. It is quite impossible to analyze the avifauna of Mexico, disregarding

the adjacent southwestern United States, and the mountain ranges south of Chiapas and Guatemala, where similar climates and major ecological habitats are continuous.

1. The families represented include 11 plus 1 subfamily, whose members are now primarily tropical in distribution. In every case those species which breed north well into the United States are highly migratory and winter in the tropics.

2. Only two species have entered the humid tropics, as part of their range only (*Psilorhinus*).

3. Note that a substantial percentage of the total avifauna of arid tropical Mexico is composed of endemic species belonging to North American families and genera.

4. Only six species have one or more subspecies in the eastern U. S., east of the Great Plains.

5. Only two genera have a distinct species in the eastern U. S. The Ruby-throated Hummingbird, *Archilochus colubris*, breeds exclusively in the eastern U. S., joining its western relative, *alexandri*, in Mexico in winter. The genus *Toxostoma* (Thrashers) has the species *rufum* in the eastern United States, closely related to *longirostre*.

6. Such cases furnish an excellent illustration of the possibility for endless debate. Did *Toxostoma* originate in middle America, because of the presence of *rufum*, in which case Mexico was a secondary center of evolution? Or did the genus originate in Mexico, with one aggressive species entering the eastern U. S.?

7. There is no hard and fast line, separating the species in group a from group b. I therefore, decline to hazard any guess as to whether these genera and species originated in Middle or Warm North America.

8. The dubious propriety of attempting to do so is even better brought out in studying the last element in the avifauna of Mexico.

VII. Birds belonging to the modern Holarctic or circumpolar element of Dunn and Simpson.

Family	Breeding in Mexico	Visitant
Gaviidae, Loons		3 species
Colymbidae, Grebes	Eared Grebe	
Anatidae, Swans		2 species
Geese		4 species
Ducks		17 species
Mergansers		3 species
Accipitridae, Hawks	Goshawk	
	Golden Eagle	
	Bald Eagle	
	Marsh Hawk	

Family	Breeding in Mexico	Visitant
Falconidae, Falcons		<i>Falco columbarius</i> ,
Gruidae, Cranes		2 species
Rallidae, Rails		<i>Porzana carolina</i> ,
Charadriidae, Plover		6 species
Scolopacidae, Shore Birds		20 species
Phalaropodidae, Phalaropes		3 species
Stercorariidae, Jaegers		3 species
Laridae, Gulls and Terns		11 species
Alcidae, Auks, etc.	Auks, 3 species	Auks, 2 species
Strigidae, Owls	Saw-whet Owl	Long-eared Owl
Picidae, Woodpeckers	<i>Dendrocopos villosus</i>	
Alaudidae, Larks	Horned Lark (<i>Otocorys</i>)	
Corvidae, Crows	Raven	
	<i>Nucifraga</i> (Clarke's Nutcracker)	
Paridae, Titmice	<i>Parus gambeli</i>	
Sittidae, Nuthatches	<i>Sitta</i> , 2 species	
Certhiidae, Creepers	<i>Certhia familiaris</i>	
Chamaeidae	* <i>Chamaca</i> , the Wren-Tit	
Sylviidae, Warblers	<i>Regulus satrapa</i>	<i>R. calendula</i>
Motacillidae, Pipits		<i>Anthus spinoletta</i>
Laniidae, Shrikes	Loggerhead Shrike	
Fringillidae, Finches	<i>Hesperiphona vespertina</i>	
	* " <i>abeillei</i>	
	* <i>Carpodacus mexicanus</i> , and 2 other species	
	<i>Spinus pinus</i> , Pine Siskin	
	<i>Loxia curvirostra</i> , Red Crossbill	

1. Note that only one genus and two species are endemic in Mexico and the Western U. S.

2. *Hesperiphona* is the only non-arctic North American genus. It is closely related to the Asian *Mycerobas*. It might be put in group VIa with some propriety.

3. The species divide about equally into 2 groups. About half are distinct representative North American species. Thus, the Bald Eagle, *Halizetus leucocephalus*, clearly represents the Old World *H. albicilla*, the Sea Eagle, and the Redhead duck replaces the Pochard. In about half the cases, the species is common to both hemispheres, a tendency which increases northward as we approach the arctic.

4. The only basis for not putting those species in the first category above in Group VIa is 1) they belong in world-wide or Holarctic genera, or primarily Old World families, instead of New World genera or families, and 2) the breeding range of the species extends north into Boreal North America.

5. In five cases, the species ranges south of Guatemala in high mountains. The Hairy Woodpecker reaches western Panama, and the Horned Lark reappears in high mountain savannahs in the Andes of Colombia. Every species concerned represents a recent Pleistocene invasion from the North, as far as its Mexican and Central American range is concerned.

6. The pros and cons debated here show the final impossibility of guessing the origin of any of these birds, with no fossil record. Actually it makes all the difference in the world whether we are thinking of the origin of the family, genus or species. In some cases fossils give us clues as to the locus of origin of the family, very rarely for certain old genera, never for the species. In the whole order Passeres, the welter of Modern "families" cannot have any locus of origin determined by fossils, as these families possess no known osteological characters!

7. The historically minded ornithologist must resort to some method of analysis, similar to that adopted here. The family is the primary unit. Its locus of origin is determined by a fossil record; this may be safely assumed, if it is confined to a limited geographic area, or if, as with the Creepers, or Certhiidae, it is an Old World family, with some subspecies of one species only in North America. Widely ranging families usually have several secondary centers of evolution, groups of genera and species, either in different hemispheres or in different parts of the New World; it is a pure guessing game, which of these centers, if any, may have been the primary one. In some families there is only one obvious present day center of evolution, and it is tempting to infer that it is primary rather than secondary. All too often early fossils have turned up in some part of the world where the family is now extinct.

8. The final speculative trap is the endeavor to date the arrival of a supposed Old World family in the New World as early or recent on the basis of the degree that the New World representatives are different from their congeners. While this is unquestionably valid in many cases, a margin of error is bound to exist, as there is the implied premise that all groups of birds vary or evolve into new species and genera at about the same degree of evolutionary speed. The systematist can prove that this is not true, and in some cases the fossil record also proves it. Thus the Cranes and Grouse have been in North America since Eocene time, but the two cranes are only specifically distinct, whereas there are a welter of peculiar genera and polymorphic species in the latter. I therefore conclude that the game-birds are more plastic than cranes.

9. For these reasons I decline to push the historical analysis of Mexican birds any further than done in this paper.

We are now prepared to present a summary of the results in tabular form.

Summary of Mexican Species Analyzed

	Resident	Visitant
Pelagic sea birds	21	16
West Indian element	12	0
Widely ranging element:		
Temperate and tropical	88	2
Tropical only	65	0
South American element	147	0
Preglacial relicts	68	0
Old North American element:		
Middle North America	52	125
Sonoran endemics	255	0
Modern Holarctic element	25	83
Totals	733	226
Grand Total	959 ¹	

Summary of Endemic Genera and Species

	Genera	Species
Pelagic sea birds	1	6
West Indian element	0	0
Widely ranging	0	0
South American	0	0
Preglacial relicts	7	27
Old North American element:		
Middle American	0	1
Sonoran	60	255
Modern Holarctic	1	3
	69	292

CONCLUSIONS

a) Ecological

1. No less than 165 resident species and 210 visitants are so widely ranging in the New World as to defy ecological classification. Only 76 of them require a tropical climate.

2. 117 species of the South American element are confined and absolutely dependent upon humid tropical rain forest; 29 others require rain forest, but in subtropical or temperate climates.

¹ By no means including all species recorded from Mexico. Some are stragglers. The special species of Guatemala and the high mountains of Costa Rica are not counted.

3. The pre-glacial relicts occur in various climates, including arid temperate (montane pine forest), but not in deserts.

4. The Middle North American element barely enters tropical climates and deserts, but otherwise most of the species are sufficiently adaptable to defy ecological classification. Most are "woodland" species or prefer "fields" or "savannahs", or "water" habitats.

5. The modern Holarctic element also barely enters an arid tropical or desert climate, but otherwise most of the species are adaptable, many of them amazingly so. It is suggested that the adaptability shown by these birds is in part responsible for their ability to breed in north temperate latitudes, their survival of the Ice Age, and their recapture of much territory since the recession of the ice.

6. The Sonoran endemics are about evenly divided between the deserts, the arid tropics, and montane forests, both humid and arid (pine and oak).

7. The occurrence of the pelagic sea birds is almost wholly on ecological grounds, so far as we know.

8. Any further analysis along ecological lines brings us to the Biotic Province. This has recently been as well done as possible for Mexico by Goldman and Moore, 1945, a paper to which interested readers are referred. No real improvement can take place until the botanists catch up with the much better known mammals and birds.¹

b) Zoogeographical

1. To those who prefer the old fashioned descriptive method of approach, the table-land of Mexico, and a strong element in the higher mountains of Central America, are an integral part of North America.

2. Descending from this table-land and entering the humid tropical forests of southeastern Mexico, we encounter another 146 species of birds, which either range into South America, or whose relatives are wholly South American. As we proceed southward in Central America, this list has risen to 400 species by the time we reach eastern Costa Rica. This humid tropical belt is an integral part of the Neotropical Region. Endemism is very low.

3. Scattered here and there in Mexico are a few "relict" species of South American affinities.

4. The arid tropical zone of the Pacific coastal plain of western Mexico and the arid tip of the Yucatan Peninsula (Griscom, 1926a). possess a minor element of birds of South American or "Neotropical" affinities. The majority are modified, and endemism is high. The

¹ Actually this is a third method of approach to the study of the biota of any substantial portion of the earth's surface. Its validity will be discussed in another connection in the much better known areas of the eastern United States.

major element in the avifauna is composed of highly modified birds of North American origin and relationships.

5. The Subtropical Zone, as expounded by Chapman in the Andes, is destroyed in Mexico and Guatemala. This belt of rain or cloud forest with a subtropical climate, exists in Guatemala, and is found in Mexico in Vera Cruz, in the Transverse Volcanic Axis, and in the Sierra Madre del Sur in Guerrero (Griscom, 1934). Only 25 species, characteristic of this Zone, in the Andes and the mountains of southern Central America, range north to Mexico. This very marked habitat in Mexico is filled by modified birds of North American affinities.

6. The balance of Mexico is in the Temperate Zone, which reaches sea level in northwestern and northeastern Mexico. As we approach the United States border in the mountains, the familiar Life-Zones of North American zoologists become ever more sharply defined. We meet familiar birds in the Transition and Canadian Zone oak, pine, fir and spruce forests at higher levels. The bird-life of the Upper Sonoran yellow pine forest and the lower Sonoran deserts is almost identical across the international boundary.

7. Still continuing Chapman's system of describing and naming Faunas in Colombia and Ecuador, Mexico can also be divided into Faunal Areas. These are so nearly coextensive with the Biotic Provinces of Goldman and Moore (1945), as to require no further discussion at this time. Interested readers will note, however, the degree to which subspecies rather than species and genera have to be used as "indicators", another way of showing how widely ranging most avian genera and species are. Further details, and longer lists of the flora, mammals and birds can also be obtained from the chapter on Mexico in the Naturalists Guide to Americas. (Nelson and Goldman, 1926.)

8. Out of a total of 733 breeding species, no less than 39% are endemic. The Sonoran endemics alone constitute 34% of the resident avifauna.

9. In addition to these endemic species, local variations among them produce over 1000 endemic subspecies. To these must be added 69 endemic genera, and three peculiar North American families, the Turkeys, the Ptilonotidae or Silky Flycatchers, and the currently recognized Vireonidae or shrike-vireos.

10. Moreover, Mexico has been an evolutionary center for many North American families and genera, the American Quail, the motmots, the vireos, the woodpeckers of the genera *Dendrocopos* and *Centurus*, the orioles (*Icterus*), the wrens and emberizine sparrows, to mention only a few. Every known genus of American Quail occurs in Mexico, while seven out of 9 are endemic. In the sparrow genus *Aimophila*, 11 out of 13 species are endemic.

11. The last three items in combination serve to define and characterize the Sonoran Subregion, the equivalent of Simpson's "Warm North America", which an analysis of modern birds validates perfectly.

12. The Sonoran Subregion includes the southwestern United States, and the southern coastal prairies and Edwards Plateau sections of Texas; southward it continues in the mountains of Central America to western Panama; some of its characteristic birds range south in tropical climates on the Pacific coast to northwestern Costa Rica. Northward some of its characteristic birds breed at higher altitudes in the Sierras and Rocky Mountains, migrating southward in winter.

13. The New World is readily divisible into the five "regions" of Simpson, plus a sixth on the basis of modern birds.

a. Boreal or Holarctic North America — very limited in variety, but with 3 peculiar families and many genera.

b. Middle North America — no endemic family, but a variety of genera and species in the United States, in addition to those listed in this paper, which reach Mexico.

c. Warm North America — as defined above, the third richest in endemics.

d. Equatorial South America — the greatest number of peculiar families, many genera and a vast number of species, some extending north to southern Mexico.

e. Andean South America — the Subtropical and Temperate Zones from Costa Rica to Bolivia; another great welter of genera and species, but 9 equatorial families are lacking; the second richest.

f. Temperate or Austral South America — five special families, many endemic genera, but a limited variety of species. Includes the Paramo Zone of the Andes.

14. The ornithologist can see no more reason for combining sections d and e, than sections b and c.

15. Dunn's strictures on the old concept of the Neotropical Region are largely correct. The inclusion of the avifauna of Temperate South America in the Neotropical Region is absurd; its disconformity is even greater than that between the Holarctic and Middle North America.

16. Sections b and c could be combined as subregions into a North American Region (the term Nearctic is misleading). The Neotropical Region should be restricted to sections d and e.

17. Most new World Families of birds occur in all six of these "regions". Old ideas about the "Neotropical" families of birds go back to a period when an analysis of so called "Nearctic" birds stopped at the U. S.-Mexican boundary, and all families occurring south of the Tropic of Cancer were spoken of as "tropical American".

18. Actually only twelve small families of birds occur exclusively in tropical climates today. The hummingbirds, Trochilidae, for instance, and the Tyrants (Tyrannidae), supposed by Dr. Mayr to be "probably originally South American," show the absurdity of this view-point. Actually two thirds of the genera and species of Hummingbirds do not occur in the tropics, and about half of the tyrants. Warm North America has been a major evolutionary center for both.

19. Thus a proper analysis of the avifauna of Mexico involves at least a "bird's-eye" glance at the whole New World.

c) Historical

1. The weight of evidence and authority is against the arrival of any terrestrial order of birds in the New World by any early "southern" route. (Simpson, 1940)

2. The origin of modern orders of birds somewhere in the Northern Hemisphere in Eocene (chiefly) time is clearly proved by the fossil record. In North America alone there is a fossil record for 14 orders and 27 families in Eocene and Miocene deposits, and this number could be considerably extended by adding those from the Old World. (Wetmore, 1940; Romer, 1946)

3. The sad lack of avian Tertiary fossils from South America has no value as negative evidence. The assumption that there were few birds in South America during early Tertiary time is too ridiculous to merit discussion. As birds developed a little earlier than mammals, there must have been a rich and varied avifauna in South America, just as we know there was for mammals.

4. An analysis of modern birds in South America makes it impossible to divide them into two clear groups, old and relatively recent, as is so readily demonstrable in mammals. There are two obvious factors making for reconciliation, (1) the extreme adaptability of birds to varying climates and habitats. (2) their extreme motility and proclivity to wander, thus greatly reducing the effect of the Central American Tertiary water-gaps.

5. It follows, therefore, that most orders of living birds are Old Northern in origin, and the great majority of families now present in the New World (79). The maximum possible number of South American families inferentially autochthonous, as well as endemic, is 22, and I hazard the guess that palaeontological discovery will reduce this number in the future, just as it has in the past. I venture to predict that many of the fossil birds to be discovered in the early Tertiary formations of South America will prove to belong to strange orders and families, now extinct, just as with mammals; but that the

percentage assignable to modern families may run higher than in mammals. These 22 families of birds represent Dunn's South American fauna; an unknown number of genera and species of at least fourteen of these families reached Mexico and Central America prior to the period of Pleistocene glaciation; some of them survived as relicts in Mexico and the mountains of Central America; a still smaller number have been moving northward with the return of warmer climates and the recent northward march of humid tropical forests.

6. The modern Holarctic fauna of Dunn contains three special families, the loons, alcids and phalaropes, and many genera and species, most of which reach Mexico only as winter visitors. These three special families furnish an ideal illustration of the clash between the descriptive facts of present distribution and their history. The first two have a history which goes back to Eocene deposits in parts of Europe and the United States, which most certainly did not enjoy the boreal-arctic climates, to which the loons and alcids are now confined in the breeding season. It can consequently be argued that their existence in this climate is a recent adaptation, and they have just as much right to be thought of as Old Northern as any other family.

7. The refrigeration of climate in the Northern Hemisphere, which began in late Pliocene time and culminated in the Ice Age, initiated a period of wholesale southward migration and extinction. Group after group of Old Northern families and genera must have passed south through Mexico, leaving some members behind, on their way to tropical America, where the majority of living members now only survive. I suggest that a substantial number of the endemic genera and species of present day Mexico originated from this late Pliocene migration.

8. During the maximum period of refrigeration of climate, the South American element was virtually destroyed in Mexico, and the modern Boreal element along with members of Old World families of recent arrival in the New World passed through Mexico in turn, and penetrated to southern South America. Aggressive and adaptable types like *Zonotrichia capensis* and *Parula pitayumi* are now widely distributed throughout. Others survive as relicts, like the *Aimophila* sparrow and the little *Dendrocopos* woodpecker in temperate South America, the *Dendrocopos* in the mountain eloud forests of western Panama, the Crossbill and the Creeper in the upper tropical pine forests of Nicaragua.

9. Further than this we cannot safely go. While Warm and Middle North America are valid zoogeographic concepts as far as modern birds are concerned, the Old Northern families of birds in Dunn's

sense cannot be divided into two groups. In the first place the fossil record is inadequate; in the second place there is the matter of climate in the historical sense; we are assured that formerly Middle North America enjoyed an even warmer climate than that of Warm North America today.

10. As is only natural and proper in an historical summary, we have reached Mexico and its modern bird-life last. In a geographic and historical sense Mexico has always existed. For 150 million years it has been available for colonization by birds, always directly from the north, never seriously unreachable from the south. Thanks to its varied topography, innumerable climates and habitats, it has proved to be one of the major areas for secondary evolution of birds in the New World, and a last haven for relict or hard pressed species. Hence its comparatively enormous avifauna, with a high percentage of endemics, in a world the bird-life of which was terribly impoverished by the Ice-Age.

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